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APPLE CULTURE

....IN....

Los Angeles County 1903/

....BY....

FRED'K MASKEW

ISSUED BY THE BOARD OF SUPERVISORS,
LOS ANGELES COUNTY, Ca.

This bulletin was prepared under the direction of the Apple Growers'
Association and the Horticultural Commission by the
Secretary of the Association

JANUARY, 1903

To the Hon. Board of Horticultural Commissioners, Los Angeles, Cal.

Gentlemen: A resolution adopted by the members of the Apple Growers' Association of Los Angeles County in January of the present year, pledging themselves to co-operate with the Horticultural Commission is combating the insect pests and fungus diseases infesting the apple orchards, and declaring their belief that vigorous and concerted efforts would eventually restore the industry to a profitable basis, resulted in my being detailed to investigate the condition of the apple orchards, and endeavor to locate the causes of failure, both on the part of the trees to produce profitable crops of fruit, and of the owners to control the ravages of the pests that infest them. The investigations were confined to the apple orchards of the Fourth Supervisorial District, and the following is submitted as a report of the case:

These investigations and experiments were conducted in addition to the general inspection work required in the district.

FRED'K MASKEW.

Observations on the Apple Industry in this County

—Meetings

Monthly meetings were held in the several localities where apples are grown commercially, and as a rule were very well attended. A complete collection of the insects, and illustrations of the diseases infesting the apple, were exhibited at these meetings for the purpose of familiarizing the growers with the different forms, and soliciting inquiries regarding their habits, also a list of the publications of the Department of Agriculture and of the different Experiment Stations dealing specifically with the same from an economic standpoint. A special effort was made to induce the growers to apply for the Bulletins dealing with their own peculiar troubles, in the hopes that it would not only lead to a better understanding of causes and remedies, but would suggest lines of thought for further observations and experiments.

The policy adopted was to make the principal topic of discussion at each meeting a timely one, one covering the work needed in the orchard during the following month, and by introducing a paper upon the subject lead up to a discussion which would bring out the ideas and experience of those who have been actually engaged in this work in this locality for a great many years. These subjects were not confined to insecticidal and fungicidal work alone, but included the principles of planting, pruning, cultivating, picking, packing, storing and marketing apples.

Committees were appointed in the different localities to promptly report the appearance of any new pest, and also to gather data and furnish reports on the following subjects: Relative blossoming time of different varieties for pollination purposes; dates of first appearance of codling-moth and first appearance of worms in the fruit; date of first appearance of fungus on fruit; approximate cost of the different spraying operations.

The Orchards

With but very few exceptions, the apple orchards that have come under this investigation are merely incidental to the general business of agriculture, and the first and fundamental cause of their failure to produce profitable crops of fruit is neglect. The land is utilized to its fullest extent in the production of other crops (often weeds) and whatever fruit is obtained is considered as clear gain. Pruning is practiced with a view to the ease of close cultivation rather than to the health and vigor of the trees, and spraying is interfered with and generally made impossible by the presence of the crops grown between the tree rows.

Fertilizing as understood by the growers of citrus fruit in this county is unknown. The relation that this may have to the failure to produce profitable crops of apples by some of the older orchards where the trees are set 108 to the acre may be inferred from the following statement of Prof. I. P. Roberts, who, in an experimental study of the question, found that in allowing 35 trees to an acre and a yield of 15 bushels to a tree, the plant food removed in 20 crops of apples and the leaves for the same period, amounted in round numbers to 1,337 pounds of nitrogen, 310 pounds of phosphoric acid, and 1,895 pounds of potash.

That they should produce any fruit at all under the system of care that has been in vogue in many of them for the past ten years, is surprising, and is proof of the extraordinary vitality of the apple and ability to adapt itself to circumstances.

In the commercial apple orchards where varieties adapted to the location and cross-pollination have been planted, where thorough cultivation is practiced,—“where the land is tilled for the land's sake,” and not merely to kill weeds,—where pruning is done with a definite object in view, and spraying operations conducted at the proper time, the tendency of the standard commercial varieties, White Winter Pearmain, Yellow Bellefleur and Missouri Pippin, is to overbear, and a full crop of apples is the rule rather than the exception. The only exception to the foregoing statement that has come

to my knowledge, is where large blocks of a single variety have been planted and the question of proper cross-pollination has either been neglected or not properly understood.

The Soil

The soils of the moist bottom lands of Downey, Compton and Cerritos, where the majority of the apple orchards included in this investigation are located, are all more or less underlaid with alkali. Some of the best and most productive apple orchards are in lands heavily impregnated with alkali, but the rise of these salts is often very disastrous to the trees, and especially so in orchards where the trees have not attained sufficient size to shade the ground. The direct cause of the injury is the destruction of the fine root hairs by the corrosive action of the salts in their passage through the soil, and results in the drying up and eventual fall of the foliage and often death of the tree. This trouble is very perplexing to the newcomers, often occurring in orchards where the soil shows no surface indication of alkali at all, and were it not for the fact that it generally occurs in spots or small areas, and sometimes upon a single variety of apple, would be taken for drought, the effects of which it very much resembles. A thorough investigation by competent authority would probably reveal root rot induced by defective soil conditions to exist over an extensive area.

Pollination

But very little, if any, consideration has been given to this important factor in the successful fruiting of commercial orchards. Large blocks of a single variety—White Winter Pearmain—have been planted and arriving at a bearing age have blossomed full, year after year, but set little or no fruit, even in the most favorable seasons. This would suggest at least partial sterility. Cross-pollination is now an established orchard practice, and is recognized as not only increasing the quantity, but the quality of the fruit.

To be successful as cross-pollenizers, varieties must bloom simultaneously, and the following list of blossoming time of the different varieties grown in Los Cerritos is here recorded as a guide for future planting:

Varieties	First Bloom	Full Bloom	General fall of Bloom
W. W. Pearmain	April 11th	April 27th	May 5th
Red Astrakhan	" 17th	" 30th	" 12th
Belleflower	" 20th	" 30th	" 16th
Fall Pippin	" 20th	May 5th	" 15th
Rhode Isl. Greening	" 20th	" 5th	" 15th
KentuckyRed Streak	" 20th	" 10th	" 20th
Early Harvest	" 21st	" 6th	" 12th
Shockley	" 27th	" 15th	" 20th
Fameuse	" 27th	" 15th	" 22d
Ben Davis	" 29th	" 15th	" 23d
Winesap	May 5th	" 17th	June 1st
Yellow Transparent	" 5th	" 16th	" 1st
None-such	" 7th	" 16th	" 1st
Missouri Pippin	" 10th	" 20th	" 1st
Alexander	" 15th	" 25th	" 1st
Smiths Cider	" 15th	" 25th	" 6th
Transcendent Crabs	" 30th	April 7th	April 22d
Hyslop	April 11th	" 22d	" 30th
Montreal	" 16th	" 24th	May 7th

The practical point of cross-pollination is this: There are certain varieties of apples which, on account of their profitableness, we wish to grow largely for the general market, but we find their productiveness is very materially reduced when planted alone.

White Winter Pearmain, Yellow Belleflower and Missouri Pippin are the standard commercial varieties grown in the moist bottom lands of this county. With a view to selecting good pollenizers for these three varieties the following tables have been prepared:

Missouri Pippin in Bloom 22 Days	Pollenizers	Length of time in bloom with Missouri Pippin						Days
		None-such	-	-	-	-	-	22
		Winesap	-	-	-	-	-	22
		Smith Cider	-	-	-	-	-	17
		Alexander	-	-	-	-	-	17
Yellow Belleflower in Bloom 26 Days	Pollenizers	Length of time in bloom with Belleflower						Days
		Pearmain	-	-	-	-	-	15
		Fall Pippin	-	-	-	-	-	25
		Rhode Island Greening	-	-	-	-	-	25
		Astrakhan	-	-	-	-	-	22
		Early Harvest	-	-	-	-	-	21
		Kentucky Red Streak	-	-	-	-	-	26
		Shockley	-	-	-	-	-	19
		Fameuse	-	-	-	-	-	19
		Ben Davis	-	-	-	-	-	17
White Winter Pearmain in Bloom 24 Days	Pollenizers	Length of time in bloom with Pearmain						Days
		Astrakhan	-	-	-	-	-	18
		Belleflower	-	-	-	-	-	15
		Fall Pippin	-	-	-	-	-	15
		Rhode Island Greening	-	-	-	-	-	15
		Kentucky Red Streak	-	-	-	-	-	15
		Early Harvest	-	-	-	-	-	14
		Fameuse	-	-	-	-	-	8
		Ben Davis	-	-	-	-	-	8

In considering the above tables it must be borne in mind that the comparative blooming of varieties is more or less a local problem, weather conditions and also soil conditions during the blooming season may not only hasten or retard the time of blossoming, but also change the order in which the different varieties open in the same locality, and while the above list of dates indicates in a general way which of our standard commercial varieties may be expected under ordinary conditions to bloom together, each prospective planter should learn how varieties bloom in his own immediate neighborhood and be prepared to make minor corrections before planting them for cross-pollination.

Pruning

Careless pruning, or to better express it, mutilation of the trees with the ax has hastened the arrival of many apple trees to their present stage of unprofitableness. The removal of the lower branches to get them out of the way of cultivation has exposed five or six feet of the trunk to the rays of the afternoon sun, and severe sun scald is the natural result, the tops are brush piles, while stubs of branches that have broken with an overload of fruit show their splintered ends or, in more ancient cases, the holes produced by the root fungi in their progress to the heart of the tree.

In opposition to the foregoing statement the better class of apple orchards show the results of thoughtful pruning and careful protection of the wounds. Every year is demonstrating more and more to the observant growers the wisdom of Prof. Wickson's advice to grow low-headed trees in California, and the coming apple orchards show a practical application of those principles.

Too much stress cannot be laid on the necessity of removing broken limbs close to the body of the tree; sap does not circulate freely in these stubs and hence no new tissue is produced. Scars caused by removing limbs, as well as all wounds and bruises, should be protected by a coat of white lead and oil, paint or pine tar. Left unprotected, they induce the growth of fungi, to which source can very probably be traced the spores that produce some of the fungus diseases attacking the fruit, and thus establish a little known connection between pruning and unprofitableness.

San Jose Scale

This scourge of the deciduous fruit trees is very generally distributed throughout the apple orchards of this district, and has been so for many

years. Various methods have been employed in combating it in the past, including hydro-cyanic gas, lime sulphur and salt, pure kerosene, kerosene emulsion, and the different brands of distillate emulsions offered for sale in the market. In no single instance has complete eradication been obtained. Growers who understand the nature of the insect do not expect eradication to result from a single annual treatment, but continue to spray every year for the purpose of maintaining commercial control, or, in other words, clean fruit.

Lime sulphur and salt is considered the sovereign remedy for this pest by the majority of growers, and in localities where this standard wash has been generally and persistently used clean fruit has been the result and the spread of the insect controlled. The proper preparation of the lime, sulphur and salt wash with the utensils ordinarily found upon the farm is a very tedious and difficult task, and the application of it over an extended period amounts to positive torture; the destruction of valves, nozzles and other parts of the spraying machinery is also very rapid.

These conditions have created a feeling of dissatisfaction even with growers who fully appreciate its efficacy, and have brought about a desire to find some other remedy that would produce as good results combined with comparative ease of mixing and applying. This desire culminated during the present season in the adoption of the use of distillate emulsions for this purpose in a large number of orchards. The results obtained even where the mixture was applied by power machines operated by professional sprayers was very unsatisfactory, and in some cases of individual application by the growers proved disastrous to the trees and fruit.

Analysis of the different brands of commercial distillate emulsions shows the oil contents to vary greatly and the stability of the emulsions when diluted to be unreliable. Until these conditions are permanently overcome the grower who decides to use emulsions should learn to prepare his own.

In combating an insect pest the nature of the remedy employed must be governed by the condition of the insect at the time of the application. Apple trees are generally sprayed for San Jose scale during the months of February and March. At this time the San Jose scale is in its hardest and most invulnerable condition, and to be successfully attacked requires the application of washes of the most caustic nature. The consistency of washes of this class prevents them from spreading easily; the scale insects located in the deeply wrinkled surface of the crooked fruit spurs and at the base of the bud scales usually escape contact, and were it not for the permanent coating left upon the tree which very probably prevents a large number of the young from obtaining a suitable location, lime sulphur and salt would perhaps prove less satisfactory than it is.

At the time of this writing (Oct. 27th) the San Jose scale on badly infested trees is breeding rapidly; the young larvae are crawling about over the backs of the old scale and swarming over the branches in every direction. It is my opinion that the females of this brood will constitute the great majority of those that successfully winter over and commence the work of reproduction next May. In this unprotected condition they may be easily killed by applications of emulsions, sufficiently diluted as to insure no damage to the tree. Those who prefer to employ this remedy will obtain more satisfactory results by attacking the larvae of these late broods than by waiting until spring, when the insects will have attained their growth and be in a fully-armored condition.

A very efficient, predaceous parasite is at work upon the San Jose scale in this district. In orchards where it has not been disturbed by disinfection of the trees very satisfactory work has resulted. Specimens of this insect sent for identification proved difficult of classification, and suggestions were received that it was probably new to science. At the time of this writing no name has been received for it.

Codling-Moth

The financial loss to the apple growers caused by the depredations of the larvae of this insect were more the cause of this investigation and the renewed interest manifested in the apple industry than any other problem. Growers complain bitterly of the destructive work of this pest, and

declare that it does not, in this county, follow the orthodox round of life, as described by writers in other apple-growing districts. They also aver that spraying with arsenites as recommended is unavailing, and does not control the destructive work of the insect upon the late varieties in the least.

Discussion of this subject by the apple growers at the meetings held during the spring months developed a great diversity of opinion as to the relative value of one or more sprayings with paris green, there being no record to corroborate the statements made. A series of experiments were planned, and the following is a record of the results obtained in one of them:

Four typical trees, 9 years old, were selected in the center of an orchard. White Winter Pearmain was chosen, as the fruit of that variety is about the last to be gathered and consequently suffers the most from the attacks of the later broods of worms. The trees were marked and sprayed as follows:

Experiment No. 0—Not sprayed at all.

Experiment No. 1—Sprayed with paris green, June 2nd.

Experiment No. 2—Sprayed with paris green, June 2nd, July 14th.

Experiment No. 3—Sprayed with paris green, June 2nd, July 14th, Aug. 25.

All the trees in the orchard except No. 0 were sprayed with paris green on June 2nd. Bands were put upon the trees June 12th and attended to carefully every 10 days afterwards. The windfalls from these trees were also promptly gathered and removed. On October 7th the fruit upon these four trees was carefully picked, weighed, counted and the worm-eaten apples separated. The result is given below:

Trees	Weight of Apples	Number of Apples	Number of Wormy Apples	Percentage Wormy
No. 0	330 lbs.	1123	320	30%
No. 1	308 lbs.	846	123	15%
No. 2	341 lbs.	971	140	15%
No. 3	363 lbs.	1214	182	15%

The percentage in round numbers of the wormy apples given in the above table, shows very plainly the great importance and value of the first spraying, the percentage of wormy apples on the tree not sprayed at all being nearly double that of any of the other sprayed trees. The failure of the second and third sprayings to further reduce the percentage of wormy apples, as shown by the record of the tree sprayed once, was very probably caused (as will be shown further along) by the applications being made at the wrong time.

A record was kept of the number of worms taken under the bands upon each of these four trees, as follows:

Trees	Bands removed.....	June	July				Aug.		Sept.			Total from each tree
		22	1	11	21	31	11	22	2	12	22	
No. 0	Worms taken.....	3	13	20	23	17	4	2	5	12	8	107
No. 1	" "	0	1	6	9	12	4	6	4	8	14	64
No. 2	" "	1	5	5	11	9	6	6	2	8	12	67
No. 3	" "	0	6	9	14	11	3	5	3	3	6	60
Total taken each time		4	25	40	57	49	17	19	14	31	40	

The above record shows that the worms are entering and leaving the fruit all summer; it also gives the approximate dates at which the larvae of the two broods reach their maximum and minimum numbers. The first brood in this instance had reached its maximum when the bands were removed on July 21st. The second maximum came on September 22nd. Upon the knowledge of when these maximums are reached depends in a great measure the success of late spraying. Scientific experiments made by entomologists have shown that the greatest hatch of the eggs takes place in from 25 to 30 days from the time the greatest number of worms leave the fruit. The probable cause of failure of the spraying in experiments Nos. 2 and 3 was the lack of this knowledge. In those experiments the greatest number of worms leaving the fruit occurring on July the 21st, the greatest amount of young worms of the next brood seeking to enter the fruit would have occurred approximately on Aug. 14th; whereas the second spraying was done on July 14th, a month too soon, and the third spraying on Aug. 25th, a week or ten days too late to catch the main crop of this second brood.

Both observation and experiment has demonstrated that it is very difficult to make the paris green stay upon the smooth surface of the fruit for any length of time, and even where the sticking qualities are improved by the use of Bordeaux mixture as a conveyor for the poison, the surface of the rapidly growing fruit is expanding in such a manner as to soon leave much of the surface uncovered. Success with late spraying for Codling-moth will probably result from applications of paris green, made just as the greatest number of young worms are about to enter the fruit. This will necessitate close observation upon the part of each individual grower. The bands, however, serve as a barometer in this case and point out with unerring accuracy the development of each brood. No fixed dates can be set for late spraying, or, for that matter, any spraying. Each apple grower should select five or six trees in different parts of the orchard, and keep a daily record of the number of worms taken under each one; he will then be able to determine when the maximum number of worms are leaving the fruit, spraying on the 25th day after the largest number of worms are taken under the bands will get the poison on the tree during the time the greatest number of newly-hatched worms are entering the fruit.

Bands

Banding the trees with strips of cloth is one of the best known methods of supplementing spraying with arsenites in this fight against the Codling-moth. Growers are recognizing this and the use of bands is becoming more general. The early varieties of apples suffer but little from the worms, and diligent attention to the bands will greatly reduce the increasing hordes that infest the late apples from the middle of August up to harvest time. These bands made from pieces of old sacks, folded once and secured around the trunk of the tree by twine or baling-wire, should be put on early in June and removed, and the worms destroyed at least once in every ten days afterwards.

Scraping the Bark

This is practiced by some growers for the dual purpose of destroying such larvae as may be wintering under the rough bark, and for compelling the worms to seek the shelter of the bands during the coming season by removing such projecting surfaces as might serve for hiding places. Various devices are used to accomplish this, but perhaps the best that has come under the writer's attention is an old well-worn rasp, such as may be found discarded in any blacksmith's shop.

Appearance of the Moths

An attempt was made to keep a record of the time of the appearance of the moths during the season. Worms were gathered from old boxes and from bands on the trees during the winter months and placed in a common fruit jar, the mouth being secured by a covering of lawn. The first moth appeared in the breeding jar on the 6th of April; on the 10th of April

the issue of moths was general, the majority of those in the jar issuing upon that day. The first moth taken outside was caught on April the 15th. On June the 24th a moth issued from pupae taken on June 22nd from beneath a band placed upon the tree June 12th. On July 1st a band, just as it was taken from the tree, was placed in a glass fruit jar; this was continued by placing a fresh band in a jar each week. On July the 2nd three moths issued; every morning afterwards these jars were examined, the live moths liberated into an inverted tumbler, cyanided, and the jar closed again. With but four exceptions Codling-moths issued every 24 hours from July 2nd until September 12th. On August the 5th an Ichneumon-fly was found among the Codling-moth escaping from the breeding jar into the cyaniding glass; these appeared again later, and grew more numerous as the month of August progressed. To guard against any possible mistake a few bands were left upon the trees until many of the larvae of the Codling-moth had gone into the pupae state. These pupae were carefully removed from the bands and placed in a separate jar, 100 in all being gathered. On Aug. 14th a count of the contents showed 32 Ichneumon flies, 11 Codling-moths and a large number of very small flies unknown to the writer. The remainder of the pupae were very much discolored, shrunk, dried and apparently dead. The large percentage of parasites issuing from this lot may probably be accounted for by the fact that the parasitized pupae were easily detected by their discolored appearance and were unquestionably selected on that account from out the number found under the bands.

Specimens of the two parasites bred out were sent to the proper authorities for identification. At the time of this writing no reply has been received.

Causes to Cull Apples

During the winter and early spring months of the present year, correspondence was had with some of the commercial apple growers in other parts of the State with a view to finding out about what was the percentage of the Codling-moth. The replies received ranged from 6 per cent up to as high as 15 per cent. Growers in the county to whom these letters were read declared that the culls in their orchards amounted to 50 per cent every year, and charged them all up to the work of the Codling-moth. With a view to getting some facts on this subject several orchards were visited at packing time and a census of what caused the culls was taken. The findings are enumerated in the following tables:

An orchard in Compton, trees several varieties, 20 years old; sprayed with lime, sulphur and salt; Bordeaux mixture before buds started; paris green twice; bands used. Count made Sept. 29th.

Sound	68 apples
Stem-ender	12 "
Codling-moth	8 "
Puncture	8 "
Leaf-folder	3 "
Fungus	1 "

Total..... 100 "

An orchard in Cerritos, trees Pearmain and Belleflowers, 10 years old; in good, thrifty condition; sprayed paris green once; no bands. Count made Sept. 30th.

Sound	55 apples
Codling-moth	20 "
Stem-ender	17 "
Puncture	6 "
Leaf-folder	2 "
Fungus	0 "

Total..... 100 "

An orchard in Compton, trees all Pearmain, 18 years old. Not sprayed at all this year. Count made Sept 29th.

Sound	48 apples
Stem-ender	32 "
Codling-moth	7 "
Puncture	1 "
Leaf-folder	5 "
Fungus	7 "

Total..... 100 "

An orchard in Cerritos, trees many varieties, 25 years old; badly run down; not sprayed with paris green; no bands used. Count made Sept 30th.

Sound	56 apples
Codling-moth	17 "
Stem-ender	20 "
Puncture	7 "
Leaf-folder	0 "
Fungus	0 "

Total..... 100 "

An orchard in Downey, trees many varieties, 4 years old, in good condition; sprayed with paris green and Bordeaux mixture twice. Count made October 6th.

Sound	77	apples
Codling-moth	3	"
Stem-ender	4	"
Puncture	11	"
Leaf-folder	1	"
Fungus	4	"
Total.....	100	"

An orchard in Downey, trees several varieties, 12 years old, in good condition; sprayed with paris green; bands used. Count made October 6th

Sound	49	apples
Codling-moth	23	"
Stem-ender	8	"
Puncture	17	"
Leaf-folder	3	"
Fungus	0	"
Total.....	100	"

An examination of the above tables will show that the Codling-moth is probably not much worse in the apple orchards of this county than in orchards in other parts of the Pacific Coast. That it is very ably assisted by other insects in the destruction of the fruit has long been recognized by some of the more observant of the apple growers. The results set forth in the above tables were all made upon Pearmain apples, that variety being supposed to suffer the most. Every effort was made to have the count a fair and impartial one, and with one exception the grading was done by the grower himself. Many of the apples marked by the different causes enumerated were not sufficiently marred as to prevent their being classed as No. 1 grade, and the number of apples classed as sound does not represent the percentage of first-class marketable apples.

In looking over the causes of culls, most of the terms will explain themselves. By puncture is meant where the small worm has commenced to burrow into the side of the apple, but rarely succeeded in entering further than $\frac{1}{4}$ inch. For some reason further operation is suspended, the wound heals over and the apple is not injured. These punctures can be readily distinguished from the work of the mature apple worm by persons acquainted with both. Many of the growers are inclined to believe this to be a different insect. I have many times seen the tiny fellow myself, but have never been able to raise one, and am of the opinion that it is the newly-hatched larvae of the Codling-moth, and that it is prevented from continuing its work by premature death from some unknown cause.

The Stem-Ende

This is the characteristic name applied by the apple growers to a little known insect that feeds around the stem of the apple, never burrowing into the fruit, but eating out extensive cavities at the base; the worm often found there is quite distinct from the larvae of the leaf-folder or the apple-worm, being much thicker and darker colored. It is a serious pest and a better knowledge of its life history might suggest some method of controlling it. Being a surface feeder, the use of arsenites immediately suggests itself as a remedy that would easily reach both this insect and the leaf-folder. A close observation, however, will show why this method often fails. When a leaf-folder devotes its attention to an apple it invariably attaches a leaf to the fruit underneath, which it works and thus protects itself from any invasion by the spray pump. With the Stem-ender he seeks out a cluster of apples where the bases touch each other in such a manner as to form a natural barrier against any attempt to furnish a change of diet. Later and more extended observations have led me to believe that perhaps some of the less characteristic work charged up in the foregoing tables to the Stem-ender, may have been caused by the gnawing of some of the larvae of the Codling-moth that pupated in that location.

Fungus Diseases

Apples grown in the district covered by this investigation suffer very severely from the attacks of the various forms of rot fungi, the most profitable variety, White Winter Pearmain, is especially subject to attack upon the wood and fruit. The present year, however, has proved the exception.

and the absence of this pest and any of its forms has prevented any observations upon the time of the first appearance of the different forms upon the fruit

Some experiments were made with Bordeaux mixture, but no conclusions can be drawn as to results, on account of the comparative absence of the pest.

Woolly Aphis

Fully seventy-five per cent of the apple trees in the Fourth Supervisorial District of this County are infested with woolly aphis. But few of the growers realize the destructive nature of this insect they see only the aerial or limb form, and overlook or are ignorant of the destructive work done by those infesting the roots. The aerial or limb forms are easily controlled by any soapy or oily washes, and the spasmodic attempts that have been made against this form of the insect have usually been successful, as far as that one brood was concerned. The same results would probably have been accomplished had no attempt at all been made, as this form of the insect is very effectively parasited by the native coccinellid beetles, and the larvae of the lace wing fly. The root form of this insect is what is causing the damage to the apple trees in this district, it attacks in immense numbers the main roots near the trunk; water sprouts appear in large numbers, the diminished supply of sap is diverted from its proper channels, the tree does not grow as it should, the roots are finally killed and then rot, support of the tree is gone and the first high wind blows it over.

In but one single instance that I know of has any systematic attempt been made to eradicate the root form of this pest, and this attempt was, I believe, successful. This was a case of 200 young apple trees badly infested with woolly aphis. The person in charge of this orchard had persistently fought the tree form for two years, with almost every kind of spray wash, the distillate emulsion had proved the most effective, but they returned in fresh colonies as fast as the preceding ones were killed. Upon explaining the habits of the insect to the man in charge of the orchards and assuring him that unless the colonies at the root were exterminated he would have to spray the trees two or three times every year, he immediately went to work and scraped the dirt away from the trunk of the tree making a basin-like cavity three feet in diameter. In this basin over the roots was poured a cupful of undiluted distillate emulsion, and the earth replaced. With the worst cases, one month later, no aphis have shown upon these trees since. The following factors may have signally helped to make a success of this method of combating the root form of woolly aphis.

1st. These trees were young at the time of treatment, being only four years old, consequently the root system was naturally limited to a small area and easily reached.

2nd. The land in this case was especially adapted to success, being a loose, open, gravelly loam.

With older, larger trees, this method of treatment might not be safe, the extended area of the root system would necessitate the use of distillate in such quantities as might eventually prove more disastrous than the pest itself. Tobacco dust has been proven to be a safe and very efficient remedy for the root form of woolly aphis. Before the winter rains commence, the earth should be removed from above the roots to a depth of four to six inches, making a circle around the tree of four to five feet. In this space three pounds of tobacco dust should be evenly distributed and the earth replaced. The rains will carry this down and around the roots and saturate the earth about the tree with nicotine, which will kill the aphis already there and prevent others from entering.

Tobacco grows readily upon the class of soil in which these infested apple trees are growing. The stronger and ranker the better for this purpose, and the owner of an infested orchard could probably make no better investment than to plant a small patch of tobacco each year, to be used for destroying woolly aphis.

Spraying

Notwithstanding the success of fumigation in controlling the insect enemies of the fruit grower, spraying will always remain a prime factor in the



production of first-class apples. Fungus diseases cannot be controlled by hydro-cyanic acid gas, and the codling-moth breeds over too extended a period to be successfully reached by fumigation. Spraying for San Jose scale has given strange results during the past season. In many orchards it has apparently done no good whatever. Complaints are common that spraying does not pay. Just why it has proved so unsatisfactory this year I am unable to say, but that is no reason why it should be discontinued. Some years the crop of apples is a failure, but no one condemns the orchard as a nuisance on that account. With the present condition of the apple orchards, the deciding of the question as to who shall have the apples in the future, the growers or the pests, will depend in a great measure upon the vigorous and intelligent use of the spray pump.

Practical orchardists now generally recognize the fact that an annual disinfection of the trees is just as essential to the production of a maximum amount of first-class fruit as are cultivation, irrigation or any other of the fundamental principles of horticulture. In my opinion this will have to be kept up indefinitely. Nature is always striving to maintain a balance in insect life. A single annual disinfection disturbs this balance, by destroying the natural causes that are striving to check the full development of the pests, and by cleaning the trees and stimulating them to a more vigorous growth and greater production of food supply for such pests as escape or may infest them from other sources. Hence disinfection by any method must be regularly followed. The maximum of first-class fruit is reached by the reduction of insect pests and fungus diseases to the minimum, and every box of first-class fruit above the average crop is what tends to put the balance on the right side of the ledger, and thus demonstrates that an annual treatment does pay.

No fixed rules can be laid down for controlling the insect enemies of the orchard; remedies may be suggested and proven, but success depends upon a careful study and accurate knowledge of the conditions in each individual case. Observations have shown the same class of insect to be in entirely different conditions in two orchards divided only by a forty-foot road. The better a grower understands the nature of the insect he is combating, the closer he watches their development, the more satisfactory will be the results he obtains.

A synopsis is here given of the approximate cost of the different spray washes used in the apple orchards, based upon prices ruling last spring:

Lime, Sulphur and Salt Wash.

	Lime.	Sulphur.	Salt.	
Quantity for 50 gallons.....	40 lbs.	20 lbs.	15 lbs.	
Cost	30c	43c	18c	\$.91
Cost of cooking.....				.40
Charge for applying.....				1.20
				<hr/> \$2.51

Bordeaux Mixture.

	Lime.	Bluestone. (Copper Sulphate.)	
Quantity for 50 gallons.....	6 lbs.	6 lbs.	
Cost	5c	45c	\$.50
Cost of applying.....			1.00
			<hr/> \$1.50

Paris Green.

	Lime.	Paris Green.	
Quantity for 50 gallons.....	3 lbs.	$\frac{1}{4}$ lb.	
Cost	3c	9c	\$.12
Cost of applying.....			.80
			<hr/> \$.92

The above figures were furnished by a contractor for this kind of work, who also stated that the cost per tree, taking an average 7-year-old tree as a basis, would be approximately as follows, all material furnished, cooked and applied:

Lime Sulphur and Salt.....	3½c per tree
Bordeaux Mixture	1½c "
Paris Green	1c "

This would make the total cost of treatment as prescribed for San Jose scale and Codling-moth for a year, about as follows, per tree:

Lime, Sulphur and Salt.....	3½c per tree
Bordeaux Mixture, before buds start.....	1½c "
Paris Green, three times.....	3c "
Scraping bark	2c "
Bands and labor attending to them.....	5c "
	<hr/>
	15c "

Picking, Packing and Marketing

Upon these operations depend very largely the financial success of apple growing. The expense attendant upon this part of the enterprise is generally greater than that of all other operations combined, and any improvements in methods or appliances that will tend to lessen this expense should be carefully studied and adopted by the growers.

The individual grower or the community in general, as the case may be, should strive to obtain a reputation for an honest and uniform pack. The grower who, by honest sorting and packing, has gained this reputation has no difficulty in finding a buyer for his crop; he generally finds the same buyer eager to take the crop off his hands each year at profitable prices. With the grower who compels his good fruit to sell his culls the reverse is true, and he can expect no permanent profit to result until he changes his methods.

Regarding the lax methods, or, more properly speaking, the entire lack of method, in harvesting and marketing the fruit in many orchards that have come under this investigation, perhaps the less said the better. What is urgently needed as the first step towards permanent improvement along this line, is the establishment of an adequate plant to work up the culls. At present the majority of these are a dead loss and the knowledge of this creates a tendency to work off as many as possible in the pack. With an established demand for this part of the crop this tendency would be overcome, an honest, reliable, uniform pack obtained; a reputation won and a profitable market assured.

Conclusions

1st. Certain varieties of apples can be very profitably grown in the moist bottom lands of this county.

2nd. The local demand for first-class fruit is far in excess of the visible supply, and should prove a stimulus to better methods of production.

3rd. Observations and experiments show that the work of the Codling-moth is apparently no worse in the apple orchards of this county than in other parts of the Pacific Coast.

4th. A careful study by a competent entomologist of the insects assisting the Codling-moth in the destruction of the fruit, with a view to a better knowledge of how to successfully fight them.

5th. A more thorough, systematic and concerted effort on the part of the growers to control the insect enemies and fungus diseases; a better knowledge of the details of preparing and of the principles governing the successful application of insecticides.

6th. A more extended acquaintance with the subject of cross-pollination and a determination by experiment of the best pollenizers for the standard commercial varieties grown in this locality. A practical testing of some of the better class of desert apples apparently suitable to local conditions, and more thorough and extensive cultivation in the younger orchards.

7th. A prompt cure for the deep-seated trouble resulting from the accumulated evils of years of neglect and the complete elimination of a continual source of infestation by the removal of many of the old orchards. Continued co-operation on the part of every member of the Apple Growers' Association with the Horticultural Commission until these ends are attained, and the apple industry of this county restored to a permanent, profitable basis.